

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

PCT

To:

see form PCT/ISA/220

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY (PCT Rule 43bis.1)

Date of mailing
(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference
see form PCT/ISA/220

FOR FURTHER ACTION
See paragraph 2 below

International application No.
PCT/CA2004/000324

International filing date (day/month/year)
03.03.2004

Priority date (day/month/year)
03.03.2003

International Patent Classification (IPC) or both national classification and IPC
G06N1/00

Applicant
D-WAVE SYSTEMS, INC.

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☒ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. FURTHER ACTION

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA"). However, this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of three months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

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**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.
PCT/CA2004/000324

Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.
 - ☐ This opinion has been established on the basis of a translation from the original language into the following language , which is the language of a translation furnished for the purposes of international search (under Rules 12.3 and 23.1(b)).
2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application and necessary to the claimed invention, this opinion has been established on the basis of:
 - a. type of material:
 - ☐ a sequence listing
 - ☐ table(s) related to the sequence listing
 - b. format of material:
 - ☐ in written format
 - ☐ in computer readable form
 - c. time of filing/furnishing:
 - ☐ contained in the international application as filed.
 - ☐ filed together with the international application in computer readable form.
 - ☐ furnished subsequently to this Authority for the purposes of search.
3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
4. Additional comments:

Box No. II Priority

1. ☒ The validity of the priority claim has not been considered because the International Searching Authority does not have in its possession a copy of the earlier application whose priority has been claimed or, where required, a translation of that earlier application. This opinion has nevertheless been established on the assumption that the relevant date (Rules 43*bis*.1 and 64.1) is the claimed priority date.
2. ☐ This opinion has been established as if no priority had been claimed due to the fact that the priority claim has been found invalid (Rules 43*bis*.1 and 64.1). Thus for the purposes of this opinion, the international filing date indicated above is considered to be the relevant date.
3. Additional observations, if necessary:

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.
PCT/CA2004/000324

Box No. V Reasoned statement under Rule 43b/s.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	1-29
	No: Claims	
Inventive step (IS)	Yes: Claims	1-29
	No: Claims	
Industrial applicability (IA)	Yes: Claims	1-29
	No: Claims	

2. Citations and explanations

see separate sheet

Re Item V.

1 Reference is made to the following document :

D1 : WO 01/50534 A (D-WAVE SYSTEMS, INC) 12 July 2001 (2001-07-12)

D2 : US 6.128.764 (GOTTESMAN) 3 October 2000 (2000-10-03)

2 INDEPENDENT CLAIM 27

2.1 Document D1, which is considered to represent the most relevant state of the art, discloses (abstract):

A quantum computing method, comprising : initializing the quantum computing system in a known state and performing a quantum computation and performing a readout on the quantum computing system to yield readout information.

2.2 From this, the subject-matter of independent claim 27 differs in the additional step of providing a dressing transformation for a quantum computing system, identifying a dressed Hamiltonian and applying the dressing transformation to undress the readout information.

2.3 The subject-matter of claim 27 is therefore novel (Article 33(2) PCT).
The application of a dressing transformation in the field of quantum computers has not been found in the prior art and is considered novel in the sense of Article 33(2) PCT.

2.4 The solution to this problem proposed in claim 27 of the present application is considered as involving an inventive step (Article 33(3) PCT) for the following reasons:

The technical effect of the difference (see point 2.2) may be regarded as: the elimination of errors occurring in a physical quantum computer generated because it differs from an ideal quantum computer.

This technical effect is normally obtained in the field of quantum computers by using

error-correcting codes see D2 (column 2 , line 44 - column 3 , line 7)

Therefore it is considered that the application of a dressing transformation to compensate for differences between a physical and an ideal Hamiltonian in a quantum computer is not obvious and is involving an inventive step in the sense of article 33(3) PCT.

3 INDEPENDENT CLAIM 1

3.1 Document D1, which is considered to represent the most relevant state of the art, discloses (abstract):
a quantum computing method, comprising : (B) initializing each qubit in said plurality of qubits to a known state, (C) performing a quantum calculation using said plurality of qubits and (D) measuring said plurality of qubits.

3.2 From this, the subject-matter of independent claim 1 differs in that:"a dressing transformation between a physical Hamiltonian and an ideal Hamiltonian is constructed".

3.3 It is clear from the description on page 10 lines 8 -11 that the following feature is essential to the definition of the invention:

(1) "applying the dressing information to the result using a post-processing method"

Since independent claim 1 does not contain this feature it does not meet the requirement following from Article 6 PCT taken in combination with Rule 6.3(b) PCT that any independent claim must contain all the technical features essential to the definition of the invention.

3.4 For Claim 1 , construed as comprising also the essential feature as mentioned in point 3.3, the same reasoning as in points 2.3 and 2.4 would apply and Claim 1 could be considered being novel in the sense of Article 33(2) PCT and involving an inventive step in the sense of Article 33(3) PCT.

4 INDEPENDENT CLAIM 29

- 4.1 Document D1, which is considered to represent the most relevant state of the art, discloses (abstract):
a quantum computing method.**

From this, the subject-matter of independent claim 29 differs in that:
computing a dressing transformation between the ideal Hamiltonian set and the Hamiltonian set for a physical system

- 4.2 Claim 29 is unclear , in particular the last paragraph : "determining the dressed states of the physical system, wherein the dressed states of the physical system and the Hamiltonian set for a physical system quantum computation using the Hamiltonian set is universal".**

- 4.3 It is clear from the description on page 10 lines 8 -11 that the following feature is essential to the definition of the invention:**

(1) "applying the dressing information to the result using a post-processing method"

Since independent claim 29 does not contain this feature it does not meet the requirement following from Article 6 PCT taken in combination with Rule 6.3(b) PCT that any independent claim must contain all the technical features essential to the definition of the invention.

- 4.4 For Claim 29, construed as also comprising the technical feature as mentioned in point 4.3 and taking into account the objection of point 4.2 , the same reasoning as in points 3.3 and 3.4 would apply and claim 29 could be considered being novel in the sense of Article 33(2) PCT and involving an inventive step in the sense of Article 33(3) PCT.**

5 DEPENDENT CLAIMS 2 - 26 and 28

- 5.1 The dependent Claims 2 - 26 and 28 , by virtue of their dependence of Claims 1 and 27 , could also be considered novel in the sense of Article 33(2) PCT and involving an inventive step in the sense of Article 33(3) PCT**